**How Insulin is Made**

**Raw Materials**Human insulin is grown in the lab inside common bacteria. *Escherichia coli*is by far the most widely used type of bacterium, but yeast is also used.

Researchers need the human protein that produces insulin. Manufacturers get this through an amino-acid sequencing machine that synthesizes the DNA. Manufacturers know the exact order of insulin's amino acids (the nitrogen-based molecules that line up to make up proteins). There are 20 common amino acids. Manufacturers input insulin's amino acids, and the sequencing machine connects the amino acids together. Also necessary to synthesize insulin are large tanks to grow the bacteria, and nutrients are needed for the bacteria to grow. Several instruments are necessary to separate and purify the DNA such as a centrifuge, along with various chromatography and x-ray crystallography instruments.

**The Manufacturing Process**

Synthesizing human insulin is a multi-step biochemical process that depends on basic recombinant DNA techniques and an understanding of the insulin gene. DNA carries the instructions for how the body works and one small segment of the DNA, the insulin gene, codes for the protein insulin. Manufacturers manipulate the biological precursor to insulin so that it grows inside simple bacteria. While manufacturers each have their own variations, there are two basic methods to manufacture human insulin.

**Where Does Commercial Insulin Come From?**

**The first successful insulin preparations came from cows (and later pigs)**. The pancreatic islets and the insulin protein contained within them were isolated from animals slaughtered for food in a similar but more complex fashion than was used by our doctor and med-student duo. The bovine (cow) and porcine (pig) insulin were purified, bottled, and sold.

Bovine and porcine insulin worked very well (and still do!) for the vast majority of patients, but some could develop an allergy or other types of reactions to the foreign protein (a foreign protein is a protein which is not native to humans).

In the 1980s, technology had advanced to the point where we could make human insulin. The advantage would be that human insulin would have a much lower chance of inducing a reaction because it is not a foreign protein (all humans have the exact same insulin, so we do not "see" this as a foreign protein).

The technology which made this approach possible was the development of recombinant DNA techniques. In simple terms, the human gene which codes for the insulin protein was cloned (copied) and then put inside of bacteria. A number of tricks were performed on this gene to make the bacteria want to use it to constantly make insulin. Big vats of bacteria now make tons of human insulin. From this, pharmaceutical companies can isolate pure human insulin.